AD NUMBER
AD020263
CLASSIFICATION CHANGES
TO: unclassified
FROM: restricted
LIMITATION CHANGES
TO: Approved for public release, distribution unlimited
FROM: Controlling Organization: British Embassy, 3100 Massachussetts Avenue, NW, Washington, DC 20008.
AUTHORITY
DSTL, AVIA 18/3791, 29 Jul 2008; DSTL, AVIA 18/3791, 29 Jul 2008

The following ESPIONAGE NOTICE can be disregarded unless this document is plainly marked RESTRICTED, CONFIDENTIAL, or SECRET.

NOTICE: THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U.S.C., SECTIONS 793 and 794. THE TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

MINISTRY OF SUPPLY

AEROPLANE AND ARMAMENT EXPERIMENTAL ESTABLISHMENT

BOSCOMBE DOWN

CANBERRA T. MK.4, WH.467
(2 X AVON 1)

HANDLING AT AFT C.G.

5/52 (A1513) Wt.33812/798. 40M. 2. 2/53. H. E. & S. Gp.848

3rd Part of Report No. A.A.E.E./861/3

AEROPLANE AND ARMAMENT EXPERIMENTAL ESTABLISHMENT
BOSCOMBE DOWN

28 AUG 1953

Canberra T. Mk.4 WN.467
(2 x Avon 1)

Handling at aft C.G.

A.& A.E.E. Ref: 5704,e/6/F.W.T.
M. O. S. Ref: 7/Acft/2711/11
Period of Test: 11.11.52 - 30.1.53.

Progress of issue of Report

Report No.	Title
1st Part AAEE/861/3	WN.467 - Appraisal of pilots' cockpit.
2nd - do -	WN.467 - Partial engineering assessment.

Summary

The Canberra T. Mk.4 was very similar to the B. Mk.2 aircraft except for the changes entailed in providing side-by-side seating for a pupil-pilot and an instructor. The main consequential differences were a slight change in shape of the fuselage nose and in aileron gearing.

The handling characteristics were very similar to those of the B. Mk.2 aircraft and there was no noticeable difference in aileron control forces. The T. Mk.4 aircraft should therefore be satisfactory, from these aspects, for its intended use for pilot familiarisation duties.

Criticisms of the cockpit layout and engineering features have been given in the 1st and 2nd parts of this Report.

This report is issued with the authority of

Air Commodore,
Commanding A.& A.E.E.

1. Introduction

The Canberra T. Mk.4 aircraft differed from the B. Mk.2 aircraft in having a modified cockpit layout and a slightly modified nose shape. An assessment of the cockpit layout has already been given in the 1st part of this Report.

The rearrangement of the pilots' cockpit to permit side-by-side seating for the pupil and instructor necessitated a slight modification of the effective control wheel diameter. Modifications were also made to the aileron control linkages such that it would be expected that the aileron control would be heavier than on the B. Mk 2 aircraft. The elevator and the rudder gearings remained unchanged.

During the brief handling assessment reported herein, particular note was taken as to the effect of the modifications to the aileron gearing on control characteristics and as to whether the revised cockpit layout imposed any limitations on the control movements under any condition of flight.

2. Condition of aircraft relevant to tests

2.1 General. The aircraft was as described in the 1st part of this Report in which was also recorded the values of the control circuit friction.

2.2 Loading. The loadings for these tests were:-

(a) without wing-tip tanks.

Weight lb.	Centre of gravity position			
	Inches aft of datum		Percentage of S.M.C.	
	U/c down	U/c up	U/c down	U/c up
30,890	34.6	34.2	29.0	28.8

(b) with wing-tip tanks.

Weight lb.	Centre of gravity position			
	Inches aft of datum		Percentage of S.M.C.	
	U/c down	U/c up	U/c down	U/c up
36,980	31.7	31.2	27.4	27.1

The C.G. during each flight was maintained sensibly constant at the take-off position by suitable use of the fuel. The maximum permissible take-off weights were:- normal, 33,050 lb. overload 37,350 lb. The maximum permissible landing weight was 27,500 lb. The design C.G. range, with undercarriage down, was from 20.22 ins. to 34.63 ins. aft of datum, that is, 0.21 to 0.29 S.M.C.

2.3 Airframe limitations. The limiting airspeeds at relevant heights were:-

Height (feet)	Without wing-tip tanks
0-5,000	450 knots I.A.S.
5,000 - 15,000	.75 I.M.N.
15,000 - 25,000	.79 "
25,000 - 35,000	.84 "
35,000 upwards	.83 "

/With.....

With wing-tip tanks the limiting airspeed was 365 knots I.A.S. or 0.8 I.M.N. The maximum normal accelerations permitted for test flying (0.9 n_1) were:-

(a) without wing-tip tanks 4.5 'g'

(b) with wing-tip tanks 2.7 'g'

2.4 Engine limitations. The limitations in force for Avon 1 engines at the time of test were:-

Engine Setting	R.P.M.	Time limit (minutes)	Jet pipe temperature °C
Maximum for take-off	7,800	15	600
Maximum intermediate	7,600	30	565
Maximum continuous	7,400	-	530

3. Scope of tests

Qualitative tests were made to assess the handling characteristics with and without wing-tip tanks, at the relevant aft C.G., with special emphasis on the lateral behaviour.

Except during simulated engine failure on take-off and in the air at 8,000 ft. all of the tests were made using symmetric power.

4. Results of tests

4.1 General. In general flying and manoeuvring, the control characteristics were not noticeably different from the B. Mk.2 aircraft. In particular the aileron control was not noticeably heavier.

The seating and control positions were not cramped and full movement of the controls could easily be obtained.

All forces quoted were estimated by the pilot.

The available trimmer ranges were:-

Trimmer	Divisions	
	From	To
Rudder	4L	4R
Aileron	5L	5R
Tailplane	2 N.U.	2 N.D.

4.2 Handling without wing-tip tanks

4.2.1 Simulated engine failure after take-off (loading (a)). A take-off was made with the flaps up and the following trimmer settings, rudder neutral, aileron 3 divs left and tailplane 1 div. nose down. The aircraft was airborne at 95 knots I.A.S. and speed built up quickly whilst the undercarriage was retracted. Engine failure was simulated, by fully throttling the port engine, when the speed had risen to 140 knots I.A.S. No corrective action was taken until two seconds had elapsed, during this time the aircraft yawed some 20° to port and rolled slightly in the same direction. Both deviations were easily corrected by small displacements of ailerons and rudder involving only light forces. There was no noticeable loss of height following the simulated engine failure.

There was no change in the behaviour of the aircraft when the test was repeated by fully throttling the starboard engine except that the deviations

/in.....

in heading and lateral level were to starboard.

4.2.2 Simulated engine failure in level flight (aircraft weight 30,500 lb.). The aircraft was trimmed in level cruising flight at 8,000 ft. with the engines set at the maximum continuous rating (7,400 r.p.m.). The airspeed was 440 kts. I.A.S. and the trimmer settings were, rudder neutral, aileron 2 divs. left, and tailplane 1 div. nose down.

Leaving the rudder free, first the port engine was fully throttled and then the test was repeated except that the starboard engine was fully throttled instead of the port engine. In both cases, no corrective action was taken until four seconds had elapsed; during this time the aircraft yawed and rolled gently some 20° towards the 'dead' engine. An aileron force of 30 lb. and a slight aileron deflection was required to raise the relevant wing. There was no noticeable loss of height and no rudder locking.

4.2.3 Stalls. All stalls were approached by reducing speed, at not more than 1 knot a second, from a straight glide at a trimmed speed between 1.3 and 1.4 times the appropriate stalling speed.

(a) Flaps and undercarriage up, engines idling, aircraft weight 30,300 lb.

The aircraft was trimmed to glide at 10,000 ft. and 120 kts. I.A.S., the tailplane setting was neutral.

The pull force required was still light at 100 kts. I.A.S. when very slight buffeting started. The buffeting increased steadily to mild buffeting at the stall. The aircraft stalled at 88 kts. I.A.S., the starboard wing dropping through some 20 - 30°. At the stall, the pull force was light and the control column central.

Normal recovery action was taken and the height lost was about 200 ft.

(b) Flaps and undercarriage down, engines idling, aircraft weight 30,100 lb. The aircraft was trimmed to glide at 10,000 ft. and 105 kts. I.A.S., the tailplane setting was full nose down (2 divs.).

A light pull force was required to reduce speed from the trimmed condition but, by 86 kts. I.A.S. when very light buffeting was noticed, a push force of about 10 lb. was required to avoid self stalling. The buffeting steadily increased to mild as the speed was decreased to the stall. The control column was central and the push force light when the stall occurred at 76 kts. I.A.S. At the stall, a moderate port aileron snatch occurred accompanied by a slight wing drop.

Normal recovery action was effective and the height loss was about 200 ft.

(c) Flaps and undercarriage down, approach power (5,000 r.p.m.) aircraft weight 30,320 lb. The aircraft was trimmed at 10,000 ft. at 100 kts. I.A.S., the tailplane setting was full nose down (2 divs.).

The pull force necessary to start reducing speed was light. At 81 kts. I.A.S., very slight buffeting occurred this persisted but did not increase in magnitude as speed was reduced to the stall. At 74 kts. I.A.S., the port wing dropped 20 - 30°; the control column was central and a push force of up to 10 lb. was required.

Normal recovery action was effective and the height lost was about 200 ft.

4.2.4 Behaviour at high Mach number (aircraft weight 30,000 lb.) Using maximum intermediate power (7,600 r.p.m.), a series of high speed runs were made in shallow dives at altitudes between 38,000 and 42,000 ft.

/With.....

With trimmer settings of: rudder neutral, aileron 4 divs.left and tail-plane 1 div. nose down, the control forces were light at 0.76 M (0.78 I.M.N.) but slight buffeting and an irregular rolling motion were encountered. With the rudder fixed, a very light aileron force was required to apply 10° bank in either direction. With ailerons fixed, a moderate foot force, in either direction, produced a sideslip of 3°.

The ailerons and rudder were fully effective and accurate turns, up to 60° bank, were made at speeds up to 0.78 M (0.8 I.M.N.).

Any further increase in Mach number caused progressively stronger buffeting. At 0.79 M (0.81 I.M.N.), there was a slight port wing drop but at 0.81 M (0.83 I.M.N.); 265 kts. I.A.S., the starboard wing dropped slightly and a force of about 40 lb. was necessary to raise the wing.

4.2.5 Lateral stability and control. The lateral stability and control of the aircraft was investigated, both at 10,000 ft. and at 40,000 ft. with the aircraft trimmed in each of the following conditions:-

(i) Level flight, engines at maximum intermediate rating, (engine r.p.m. 7,600).

(ii) Level flight, at low speed, (engine r.p.m. 5,000).

(iii) Climb, engines at maximum continuous rating, (engine r.p.m. 7,400).

(iv) Glide, flaps and undercarriage down, at the approach speed, (102 kts. I.A.S.), engines idling.

(a) Oscillatory stability. The aircraft was put into a straight sideslip of 5 degrees and the rudder and aileron controls were then freed, this was always followed by gentle rolling and yawing oscillations which damped out in 2 to 3 cycles.

(b) Behaviour in straight sideslip. With the aircraft trimmed for straight steady flight, the behaviour in straight sideslip was investigated at speeds from the approach speed, with flaps and undercarriage down, to the level speed appropriate to maximum intermediate rating, with the flaps and undercarriage up.

The aileron and rudder control forces required increased progressively as the angle of sideslip was increased. For all angles of sideslip up to 5°, to both port and starboard, the rudder force required was heavy at high airspeeds but was light at low airspeeds.

(c) Turns on one control. Turns were made, using one control, over a speed range from 102 to 450 kts. I.A.S. at 10,000 ft. and from 200 kts. I.A.S. to 0.78 M. (0.8 I.M.N.) at 40,000 ft.

(i) Using aileron only. With the rudder either fixed or free, accurate turns could be made, in either direction, up to about 60 - 70° bank; the aileron forces were light and the deflections small.

(ii) Using rudder only. A small amount of sideslip on entering turns and on returning to level was unavoidable when turning on rudder only, with ailerons fixed. When turning at high airspeeds the rudder forces were moderate (about 60 - 70 lb.), but as the speed was reduced the rudder forces became lighter until at 102 kts. I.A.S.,in the glide, they were light.

(d) Rate of Roll. An assessment of the rates of roll was made over a speed range from 110 to 400 kts. I.A.S. at 10,000 ft. by the pilot timing the roll through 90° either side of the plane of symmetry. Angles of bank were observed from the gyro horizon.

/The.....

The rate of roll for an aircraft of this type, when using a single handed aileron control force of about 30 lb. was good. There was a slight nose down tendency at all speeds except 400 kts. I.A.S. where none occurred. Deflections of the ailerons were moderate and no appreciable improvement was achieved with the use of rudder to augment the rolling power. The rates of roll measured were:-

I.A.S. (kts.)	Rate of roll (degrees per second)
110	18
300	30
400	10

(c) Changes of trim with speed and power. The aircraft was trimmed to climb at 330 kts. I.A.S. using 7,600 r.p.m. During the dive a push force of some 30 lb. was required to increase the speed to 450 kts. I.A.S.; there was little change of lateral trim.

With the engines operating at the maximum intermediate rating, in level flight at 10,000 ft., the aircraft was trimmed at a steady speed of 450 kts. I.A.S. The throttles were then closed rapidly until the engines were idling, this resulted in a nose down change of trim requiring a pull of 35 lb. on the control column; there was little change of lateral trim.

With the aircraft trimmed at 0.78 M. (0.8 I.M.N.) this test was also made at 40,000 ft. There was a nose down change of trim requiring a pull of 15 lb. on the control column; there was little change of lateral trim.

4.3 Handling with wing-tip tanks fitted. The handling qualities of the aircraft with wing-tip tanks were similar to those without wing-tip tanks, particular differences are however detailed below:-

(a) The aileron force necessary to raise a wing after a simulated engine failure in level flight was about 10 lb. heavier than when tested without wing-tip tanks see para. 4.2.2.

(b) The buffet experienced approaching the stall was very light and did not increase even with engines idling as speed was reduced. With flaps and undercarriage either up or down and engines idling, the aircraft stalled at an indicated airspeed higher by about 4 knots than with tip tanks off, for the same aircraft weight. However, under approach power conditions, the stall occurred at only about 1 knot higher indicated airspeed.

(c) Trimmed at a Mach number of 0.76 M. (0.78 I.M.N.); increase of speed to 0.79 M. (0.81 I.M.N.) caused a noticeable nose down change of trim which required a light pull force to hold. There was also a tendency to light irregular starboard wing snatching. Both effects were noticeable during turns with up to about 60° bank in either direction.

5. Discussion of results

5.1 General. The tests were of limited scope but were sufficient to show that the handling characteristics were very similar to those of the Canberra B. Mk.2 aircraft. Although it would be expected that the aileron control would be a little heavier than on B. Mk.2 aircraft, there was, in fact, no noticeable difference.

It should be noted that criticisms of the B. Mk.2 aircraft (e.g. speed of operation of tail trimmer, ineffectiveness of air brakes) apply equally to this aircraft and any modifications introduced in the former should also be incorporated in the latter aircraft.

/5.2.....

5.2 Comparison with A.P.970 requirements. Since these trials were almost entirely qualitative, little comparison with A.P.970 was possible.

6. Conclusions

The handling characteristics of this Canberra T. Mk.4 aircraft were very similar to those of the B. Mk.2 aircraft and the type should therefore be satisfactory, from this aspect, for it's intended rôle of pilot familiarisation.

Circulation List

A.D.R.D.L.2. 2 Copies 1 for Action
A.D.R.D. Projects 1 Copy
T.P.A.3/T.I.B. 75 Copies
O.C. Handling Sqdn 1 Copy
R.T.O. English Electric 2 Copies

[dstl]

Information Centre
Knowledge Services
[dstl] *Porton Down,*
Salisbury
Wilts
SP4 0JQ
22060-6218
Tel: 01980-613753
Fax 01980-613970

Defense Technical Information Center (DTIC)
8725 John J. Kingman Road, Suit 0944
Fort Belvoir, VA 22060-6218
U.S.A.

AD#: AD020263

Date of Search: 29 July 2008

Record Summary: AVIA 18/3791
Title: Canberra T Mk 4 WN.467 (2 Avon 1): handling at aft CG (centre of gravity)
Availability Open Document, Open Description, Normal Closure before FOI Act: 30 years
Former reference (Department) 861/3 Pt 3
Held by The National Archives, Kew

This document is now available at the National Archives, Kew, Surrey, United Kingdom.

DTIC has checked the National Archives Catalogue website (http://www.nationalarchives.gov.uk) and found the document is available and releasable to the public.

Access to UK public records is governed by statute, namely the Public Records Act, 1958, and the Public Records Act, 1967.
The document has been released under the 30 year rule.
(The vast majority of records selected for permanent preservation are made available to the public when they are 30 years old. This is commonly referred to as the 30 year rule and was established by the Public Records Act of 1967).

This document may be treated as UNLIMITED.